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NEW RECORDS OF MIDDLE MIOCENE ANSERIFORM BIRDS

FROM KERN COUNTY, CALIFORNIA

BY

HILDEGARDE HOWARD

NEW RECORDS OF MIDDLE MIOCENE ANSERIFORM BIRDS
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Hildegarde Howard¹

ABSTRACT. Previously unreported anseriform bones now available from the Middle Miocene Sharktooth Hill Bonebed reveal the presence of a large species with adaptations for diving not evidenced in the previously described Presbychen abavus Wetmore, 1930. The new form is described, on the basis of four specimens, as Megalodytes morejohni new genus and species. The remaining specimens are discussed as Megalodytes sp. and Anseriformes spp. The ulna previously referred (Miller 1961) to Branta sp. is included in the latter category. Megalodytes morejohni appears to have been a swan-like anserine, while Presbychen abavus was goose-like.

¹Emeritus Chief Curator of Science, Natural History Museum of Los Angeles County, 900 Exposition Blvd., Los Angeles, California 90007.

INTRODUCTION

The Middle Miocene Sharktooth Hill Bonebed is a rich fossil deposit in the upper part of the Round Mountain Silt in Kern County, California. This bonebed is exposed near the Kern River, approximately 8 to 10 miles northeast of Bakersfield, and has yielded the most diverse and best studied Tertiary fossil marine vertebrate assemblage yet known from anywhere within the Pacific realm (Mitchell, 1966; Barnes, 1976; Barnes and Mitchell, 1984). The fossil assemblage has been named the Sharktooth Hill Local Fauna (Wood, et al., 1941), and is comprised of more than one hundred species of sharks, bony fish, turtles, birds and mammals, including the rare fossils of some terrestrial mammals, reptiles, and birds that originated from the adjacent Miocene land mass. Some of the fossils to be described in this report were derived from outcrops of the bonebed adjacent to the Sharktooth Hill National Natural Landmark, as established by the National Park Service in 1976.

The Sharktooth Hill Bonebed is a single, relatively thin, but laterally widespread horizon. It has been correlated with the Barstovian North American Land Mammal Age, and with the "Temblor" provisional provincial mega-invertebrate stage of Addicott (1972), and is, therefore, between approximately 13 and 15 million years old (Wood, et al., 1941; Mitchell, 1966; Barnes, 1976; Barnes and Mitchell, 1984:4).

Bones of fossil birds are rare in this deposit, but are in a relatively good state of preservation, even when interspersed amid larger, sometimes broken and abraded bones of mammals and other vertebrates. Fifteen avian taxa have been previously reported from the Sharktooth Hill Local Fauna (Howard, 1984). These include two large anseriform birds: Presbychen abavus Wetmore, 1930 and Branta sp. (Miller, 1961). The latter record is based on a single proximal end of an ulna in the collections of the Museum of Paleontology at the University of

California, Berkeley (UCMP no. 95970).

The holotype of Presbychen abavus is the distal end of a right tibiotarsus in the United States National Museum (USNM no. 11973). As described by Wetmore (1930:93), the specimen is "strongly suggestive of the modern Canada Goose," and "intermediate in dimension between the largest of the Canada geese and the whistling swan." Over thirty years later, the species was again cited from the Sharktooth Hill Local Fauna (Howard, 1966) with the assignment of a proximal end of a tarsometatarsus and, questionably, a fragmentary proximal end of a femur. Both of these specimens are in the collections of the Natural History Museum of Los Angeles County (LACM nos. 16466 and 16465).

In the early 1970's, Dr. G. Victor Morejohn of the California State University, San Jose, was studying the Sharktooth Hill anseriform material in the collections of the University of California, Museum of Paleontology, in Berkeley. In a letter to me dated 25 March 1974, he indicated that he interpreted the proximal end of a humerus (UCMP 93050) to be in several ways more similar to that of the fossil diving duck, Chendytes, L. Miller, 1925, than to the geese or swans. He added that a proximal fragment of tibiotarsus on loan to him from the Natural History Museum of Los Angeles County (LACM 34530) was also suggestive of Chendytes.

Fourteen anseriform bones are now known from the Sharktooth Hill Bonebed, including the previously recorded material (Wetmore, 1930; Miller, 1961; and Howard, 1966), the bones noted by Morejohn, and an additional eight specimens not previously studied. Among the latter is a nearly complete tibiotarsus (LACM 123991) collected in 1982 from LACM locality 4956, near the Sharktooth Hill National Natural Landmark. This specimen provides the opportunity to compare the distal end with the holotype of Presbychen abavus. The comparison clearly indicates distinction, with the proximal end showing characters associated with the diving anseriforms. Very closely associated in the same quarry were two

femora (LACM 123992 and 123993) and a fragment of a humerus (LACM 123995) of a large diving anseriform. The present paper provides a description of a new genus and species based on this material. The possible relationship of other Sharktooth Hill anseriform specimens to this new genus is discussed.

METHODS AND MATERIALS

Acronyms used for institutions are:

LACM: Natural History Museum of Los Angeles County

UCMP: University of California, Berkeley, Museum of Paleontology

USNM: National Museum of Natural History, Smithsonian Institution

Anseriform material now available from Sharktooth Hill

Recorded Material

Presbychen abavus Wetmore 1930

Holotype (cast) distal end of tibiotarsus, USNM 11973

Referred proximal end of tarsometatarsus, LACM 16466 (Howard 1966)

Referred proximal end of right femur, LACM 16465 (Howard, 1966)

Branta sp. (Miller, 1961)

Proximal end of ulna, UCMP 95970

Material examined by Morejohn (unrecorded)

Proximal end of right humerus, UCMP 93050, loc. V71013

Proximal end of left tibiotarsus, LACM 34530, loc. 1625

Additional unrecorded material

Nearly complete left tibiotarsus, LACM 123991, loc. 4956

Nearly complete left femur, LACM 123992, loc. 4956

Nearly complete right femur, LACM 123993, loc. 4956

Incomplete left femur, LACM 123994, loc. 4956

Proximal fragment of right humerus, LACM 123995, loc. 4956

Proximal end of right humerus, LACM 122979, loc. 3162

Left tarsometatarsus lacking distal end, LACM 122981, loc. 3162

Proximal and distal fragments of right tibiotarsus,

UCMP 93051 and 93052, loc. V71013

Skeletons of modern anseriforms used for comparison are in the collections of the Natural History Museum of Los Angeles County.

SYSTEMATICS

ORDER ANSERIFORMES

Family Anatidae

Subfamily Anserinae

Tribe Cygnini

Megalodytes new genus

DIAGNOSIS: Large anserine having tibiotarsus with distal extension of inner cnemial crest projecting beyond medial edge of shaft and extending distally below level of proximal terminus of fibular crest; anterior surface of shaft very slightly rounded (nearly flat); distinguished from holotype of Presbychen Wetmore, 1930 by greater breadth than depth of condylar area and supratendinal bridge tilted posteriorly along its proximal border; and distinguished from holotype of Chendytes Miller, 1925 by less distal extension of inner cnemial crest, less flattened anterior face of shaft and less flared fibular crest.

TYPE SPECIES: Megalodytes morejohni, new species.

Etymology: From Greek Megalo, large and dytes, diver.

Megalodytes morejohni new species

Figures 1D-F; 2; 3A and D

HOLOTYPE. Left tibiotarsus with eroded proximal surface and incomplete cnemial crests, LACM 123991. Collected by Samuel A. McLeod, 8 May 1982.

REFERRED SPECIMENS. Left and right femora, nearly complete, LACM 123992 (left) and LACM 123993 (right). Proximal fragment of right humerus, LACM 123995.

LOCALITY. LACM locality 4956, quarry grid section 3, Sharktooth Hill Bonebed, Kern County California.

DIAGNOSIS. As for genus.

DESCRIPTION. Both tibiotarsus and femora resemble those of the genus Cygnus in stoutness of shaft. Positions of the ligamental and flexor attachments on the posterior face of the tibiotarsus, and relatively greater breadth than depth of distal end are suggestive of the condition in Cygnus olor (Gmelin, 1789). The anterior face of the shaft is, however, flatter and the extension of the inner cnemial crest is more flared mediad and of greater distal extent, suggesting greater diving ability. Measurements (in millimeters) of holotype tibiotarsus (measurements of Presbychen abavus in parentheses): Length 151.9; breadth of distal end 18.3 (18.6); internal depth of distal end 16.6 (19.0); breadth of incomplete proximal end 16.8; breadth from cnemial crest to fibular crest 14.6.

The femora resemble this element in Cygnus in the nearly straight shaft, when viewed anteriorly, which is greater in lateral breadth than antero-posterior depth. Distally the popliteal area is deeper than in Cygnus or Branta, but less sharply defined than in Merquus. The fibular condyle extends laterad slightly proximal to the external condyle, suggestive of the condition in the diving ducks, Tribe Mergini, but less abruptly protruded. In the Mergini the shaft is more curved and is relatively greater in depth than in breadth. Compared to the proximal fragment of a femur (LACM 16465) previously tentatively referred

(Howard, 1966) to Presbychen, the head is less proximally projected.

Measurements (in mm) of referred femur LACM 123993 (the more complete of the two femora referred to M. morejohni): Length from neck to distal edge of rotular groove 75.4 (same as in LACM 123992); external length 81.0; breadth of distal end 22.6; depth of trochanter 15.2; breadth/depth at middle of shaft 9.5/8.5.

The characters of the referred humerus, LACM 123995, are discussed with those of humeri UCMP 93050 and LACM 122979 under Megalodytes sp.

DISCUSSION. In reporting the distal end of a femur (LACM 125994) of a large diving anatid from the Middle Miocene of Orange County, California (Howard and Barnes, 1987) a relationship to this Sharktooth Hill anseriform material was postulated. As now studied in more detail, the following distinctions of the Orange County femur from the femora of Megalodytes morejohni are noted: greater antero-posterior than lateral breadth of shaft, more abrupt protrusion of the fibular condyle, and popliteal area more clearly defined externally as well as internally. These characters suggest closer affinity of the Orange County femur to the Tribe Mergini than is evidenced in the femora of Megalodytes morejohni.

Megalodytes sp.

Figures 1 G, H; Figure 3 B, C, E, F,

REFERRED SPECIMENS. Proximal shaft fragment and incomplete distal end with shaft of a right tibiotarsus UCMP 93051 (proximal) and UCMP 93052 (distal); and proximal 3/4 of right humerus (UCMP 93050), all from UCMP locality V71013; proximal fragment of right humerus (LACM 122979) from locality LACM 3162.

DISCUSSION. The distal end of the tibiotarsus (UCMP 93052) resembles that of the holotype of M. morejohni in the posteriorly tilted position of the supratendinal bridge; the proximal portion of the same specimen (UCMP 93051) suggests the same faintly rounded anterior surface of the shaft found in the holotype of M. morejohni. As the condylar area is incomplete both laterally and antero-posteriorly in UCMP 93052, the relative breadth to depth of the distal end

cannot be obtained. In breadth at the level of the supratendinal bridge, and breadth from fibular to cnemial crests, UCMP 93052 and 93051 are approximately 9 percent narrower than the holotype of M. morejohni: breadth at level of bridge UCMP 93052, 13.3 mm (in holotype M. morejohni, 14.5 mm) breadth from fibular to cnemial crests, UCMP 93051, 13.5 mm (in M. morejohni, 14.6 mm).

Humerus UCMP 93050 from the same locality as the tibiotarsal fragments has a capital shaft ridge that is less acute and more lateral in position than in Branta. Resemblance is closer to the humerus of Cygnus in the position of the crest, although it is not as prominent as in the swan. This is true, as well, of humerus LACM 122979. In both humeri, also, the head is not undercut by the capital groove. This character, as well as the presence of the capital shaft ridge, distinguishes these specimens from the humeri of the diving ducks (Tribe Mergini). Suggestive of the condition in the extinct Chendytes is the abrupt palmar receding of the deltoid crest just distal to the external tuberosity, and its sharp reduction after a brief flare. This area is eroded in UCMP 93050, but the outline of the shaft suggests the same characters.

In the fragment of humerus (LACM 123995) referred to Megalodytes morejohni, the palmar position and reduced size of the deltoid crest (where preserved) and the seemingly lateral position of the capital shaft ridge are strongly suggestive of the condition observed in UCMP 93050 and LACM 122979. The only similar measurement possible on all three specimens is breadth of shaft just distal to the deltoid crest. This shows a size ratio close to that observed between the tibiotarsi referred to Megalodytes sp. and the holotype of M. morejohni. Breadth of shaft LACM 122979, 11.5 mm, UCMP 93050, 11.7 mm, M. morejohni LACM 123995, 12.8 mm.

The similarity of the deltoid crest in humerus UCMP 93050 and LACM 122979 to that of LACM 123995, as well as the similarities noted in the tibiotarsi, justifies assignment of this material to the genus Megalodytes. Considering the

small difference in size, the possibility of referral to M. morejohni should be considered.

ANSERIFORMES SPP.

REFERRED SPECIMENS. Incomplete left femur, LACM 123994, from locality LACM 4956 (quarry grid section 10); proximal end of left tibiotarsus, LACM 34530 from locality LACM 1625; incomplete left tarsometatarsus, LACM 122981 from locality LACM 3161; proximal end of ulna, UCMP 95970 from locality UCMP V6323 assigned by Miller (1961) to Branta sp.

DESCRIPTION. Femur LACM 123994 is poorly preserved, lacking complete proximal and distal ends. Although similar in over all size to the femora referred to Megalodytes morejohni, it has greater antero-posterior than lateral breadth of shaft, and the popliteal area, although less deeply depressed than in M. morejohni, is more sharply defined externally by a longer ridge. Both of these femoral characters suggest possibly even greater adaptation for diving than is seen in the femora of M. morejohni.

The proximal fragment of tibiotarsus (LACM 34530) has the medially flared distal continuation of the internal cnemial crest characteristic of the divers, possibly to an even greater distal extent relative to the size of the bone than in the holotype of Megalodytes morejohni. However, it resembles that specimen in the position of the rugosities marking the muscle attachments on the posterior side. Measurements show the specimen to be even smaller than tibiotarsus UCMP 93051 listed herein as Megalodytes sp.: breadth from fibular to cnemial crests 12.5 mm in LACM 34530, 13.5 mm in UCMP 93051.

Tarsometatarsus LACM 122981 has a long internal calcaneal ridge, even longer than in Cygnus, and notably longer than in members of the Tribe Mergini. The specimen is markedly distinguished from the tarsometatarsus of Cygnus by the abrupt narrowing of the internal side of the shaft anteriorly, immediately below

the proximal end, and the gradual diminution in breadth (while retaining its depth) towards the distal end. This abrupt narrowing of the shaft is particularly noteworthy in distinction to the proximal end of tarsometatarsus (LACM 16466) previously identified (Howard, 1966) as Presbychen abavus. Much narrower metatarsal shaft is characteristic of diving forms such as the grebes and loons.

The proximal end of ulna that Miller (1961) assigned to Branta sp., noting that it was too small to be assigned to Presbychen, is similar in size to large specimens of B. canadensis, (Linnaeus, 1758) but with both olecranon and shaft markedly straighter. The high, straight olecranon is suggestive of the condition in Melanitta, Boie, 1822 but the straight shaft more closely resembles that of Cygnus, Bechstein, 1803.

Were it not for the occurrence of femur LACM 123994, which clearly represents a diver distinct from M. morejohni, these specimens might well have been assigned to Megalodytes.

DISCUSSION. Only one other anseriform species has been described from the Miocene of California, Branta howardae L. Miller, 1930 (see Howard, 1983). The species is based on a single distal fragment of carpometacarpus from the Late Miocene Dove Springs Formation (originally named Ricardo Formation and considered to be of Lower Pliocene age), in the Mohave desert, Kern County. There is no possibility of comparison of this fragment with the Sharktooth Hill material. Miller (1961) made no reference to it in discussing the ulna he assigned to Branta sp. from the latter locality.

Three other anseriform species have been described from earlier Miocene beds of North America: Paranyroca magna A. Miller and Compton, 1939; Dendrochen robusta A. Miller, 1944; and Anas integra A. Miller, 1944. All are from the Lower Miocene of Bennett County, South Dakota. Paranyroca is known only from two tarsometatarsi, for which the authors established a new "distinctive and

primitive anseriform family," the Paranyrocidæ, which they said "may have some special phylogenetic relation with the Nyrocinae." The holotype of Dendrochen robusta is a humerus which Miller placed in the Tribe Dendrocygnini. The mediad placement of the capital shaft ridge and the strong undercutting of the head by the capital groove distinguish the specimen from the humeri assigned to Megalodytes. Anas integra (placed in the subfamily Anatinae) is known from a coracoid (holotype) and ulna. Both clearly represent a small anatine duck, obviously not related to Megalodytes.

CONCLUSIONS

In studying the material discussed herein it became clear that at least two extinct Middle Miocene species of large anseriform birds are present in the Sharktooth Hill Local Fauna, namely Presbychen abavus Wetmore, 1930 and Megalodytes morejohni new genus and species. It is impossible to determine from the material available whether the smaller specimens herein identified only as Megalodytes sp. represent a separate species.

While Presbychen appears to have been a goose-like bird, Megalodytes is more like the swans, though with additional adaptations for diving. The temptation was strong to list this new genus under the Mergini. I felt, however, that the adaptations to diving observed were secondary. Or, perhaps, we may postulate that ancient swans had greater diving ability, which has gradually diminished through time.

Of the fourteen anseriform specimens now known from Sharktooth Hill, four do not readily fall within either of the above genera, and should best be classified only as Anseriformes spp.

In summary the anseriform specimens from Sharktooth Hill are evaluated as follows (number of specimens in parentheses):

Order Anseriformes

Family Anatidae

Subfamily Anserinae

Tribe Cygnini

Genus Megalodytes (7)

Tribe Anserini

Genus Presbychen (3)

Anseriformes spp. (4)

ACKNOWLEDGMENTS

My thanks go to members of the Vertebrate Paleontology staff of the Natural History Museum of Los Angeles County: Lawrence G. Barnes, Kenneth E. Campbell Jr., and J. D. Stewart, who were helpful in discussion of matters concerning association of material in the deposit, importance of certain osteological characters, and reading an earlier draft of this manuscript.

I want, also, to express my thanks to the United States National Museum for providing a cast of the holotype of Presbychen abavus, and to the University of California Museum of Paleontology for the loan of the specimen assigned by Miller to Branta sp. and specimens now assigned to Megalodytes sp. Some of the specimens were collected from the Sharktooth Hill Bonebed during field operations supported by National Science Foundation Grant No. EAR 79 16508.

I am especially grateful to Dr. Pierce Brodkorb of the University of Florida who, when I met with difficulty in finding a scientific name (not already in use) for a diving bird of large size, came up with the suggestion of Megalodytes.

The bones were prepared for photographing by Howell Thomas of the LACM Vertebrate Paleontology Laboratory, photographed by John DeLeon, LACM Photographer, and arranged for plates by Mary Butler of the LACM Exhibitions Division.

LITERATURE CITED

- Addicott, W.O. 1972. Provincial middle and late Tertiary molluscan stages, Temblor Range, California, In Proceedings of the Pacific Coast Miocene Biostratigraphic Symposium, Society of Economic Paleontologists and Mineralogists, ed. E. H. Stinemeyer, 1-26.
- Barnes, L.G. 1976. Outline of eastern North Pacific fossil cetacean assemblages. *Systematic Zoology* 25(4):321-343.
- Barnes, L.G., and E. D. Mitchell. 1984. Kentriodon obscurus (Kellogg, 1931), A fossil dolphin (Mammalia: Kentriodontidae) from the Miocene Sharktooth Hill Bonebed in California. *Contributions in Science, Natural History Museum of Los Angeles County* 353:1-23.
- Howard, H. 1966. Additional avian remains from the Miocene of Sharktooth Hill, California. *Los Angeles County Museum Contributions in Science* 114:1-11.
- 1983. A list of the extinct fossil birds of California. *Bulletin of the Southern California Academy of Sciences*, 82(1):1-11.
- 1984. Additional avian records from the Miocene of Kern County, California with the description of a new species of fulmar (Aves: Procellariidae). *Bulletin of the Southern California Academy of Sciences*, 83(2):84-89.
- Howard, H. and L.G. Barnes. 1987. Middle Miocene marine birds from the foothills of the Santa Ana Mountains, Orange County, California. *Contributions in Science Natural History Museum of Los Angeles County* 383:1-9.
- Miller, A.H. 1944. An avifauna from the Lower Miocene of South Dakota. *University of California Publications Bulletin Department of Geological Sciences*: 27:85-99.
- Miller, A.H. and L.V. Compton. 1939. Two fossil birds from the Lower Miocene of South Dakota. *Condor* 40: 153-156.

Miller, L. 1925. Chendytes, a diving goose from the California Pleistocene.

Condor, 27:145-147.

-----, 1961. Birds from the Miocene of Sharktooth Hill, California. Condor
63:399-402.

Mitchell, E.D. 1966. The Miocene pinniped Allodesmus. University of California
Publications in Geological Sciences 61:1-46, pls. 1-29.

Wetmore, A. 1930. Fossil bird remains from the Temblor Formation near
Bakersfield, California. Proceedings of the California Academy of
Sciences, 4th ser., 19:85-93.

Wood, H. E., 2nd, R.W. Chaney, J. Clark, E.H. Colbert, G.L. Jepson, J.B. Reeside,
Jr., and C. Stock. 1941. Nomenclature and correlation of the North
American continental Tertiary. Geological Society of America Bulletin
52:1-48, pl. 1.

FIGURES

Figure 1. Anserine tibiotarsi: A-C Presbychen abavus, holotype USNM 11973; A, posterior, B, internal, C, anterior views; Megalodytes morejohni LACM 123991, holotype: D, anterior, E, posterior, F, internal views; Megalodytes sp. anterior view: G distal end UCMP 93052, H proximal fragment UCMP 93051.

Figure 2. Femora referred to Megalodytes morejohni: right (LACM 123993) A, posterior, B, external, C, anterior views; left (LACM 123992) D, posterior, E, external, F, anterior views.

Figure 3. Megalodytes humeri: A-C anconal, and D-F palmar views. A, D Megalodytes morejohni LACM 123995; B, E Megalodytes sp. LACM 122979; C, F Megalodytes sp. UCMP 93050. (37 mm of incomplete shaft of 93050 not shown.)

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Branta sp. (Miller, 1961);

Proximal end of ulna, UCMP 95970.

Material examined by Morejohn (unrecorded):

Proximal end of right humerus, UCMP 93050, loc. V71013;

Proximal end of left tibiotarsus, LACM 34530, loc. 1625.

Additional unrecorded material:

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Left tarsometatarsus lacking distal end, LACM 122981, loc. 3162 ;

Proximal and distal fragments of right tibiotarsus,

UCMP 93051 and 93052, loc. V71013

The 50

Skeletons of modern anseriforms used for comparison are in the collections of the Natural History Museum of Los Angeles County, and include 12 specimens of the genus Cygnus, 10 of Branta, 8 of Anser, plus 8 representatives of the Tribe Mergini and one or more of each of the other tribes recognized in the 1983 edition of the American Ornithologists' Union Checklist of North American Birds.

SYSTEMATICS

ORDER ANSERIFORMES

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Family Anatidae

Subfamily Anserinae

Tribe Cygnini

Megalodytes new genus

DIAGNOSIS: Large anserine having tibiotarsus with distal extension of inner cnemial crest projecting beyond medial edge of shaft and extending distally below level of proximal terminus of fibular crest; anterior surface of shaft very slightly rounded (nearly flat); distinguished from holotype of Presbychen Wetmore, 1930 by greater breadth than depth of condylar area and supratendinal bridge tilted posteriorly along its proximal border; and distinguished from holotype of Chendytes^{L.} Miller, 1925 by less distal extension of inner cnemial crest, less flattened anterior face of shaft and less flared fibular crest.

TYPE SPECIES: Megalodytes morejohni, new species.Etymology: From Greek Megalo, large, and dytes, diver.*cap*

3-D
3-E
3-H

Megalodytes morejohni new species

Figures 1D-F; 2; 3A and D

HOLOTYPE: Left tibiotarsus with eroded proximal surface and incomplete cnemial crests, LACM 123991. Collected by Samuel A. McLeod, 8 May 1982.

PARATYPES:
REFERRED SPECIMENS:

Left and right femora, nearly complete, LACM 123992, 123993, (left) and LACM 123995 (right): Proximal fragment of right humerus, LACM 123995.

LOCALITY: LACM locality 4956, quarry grid sections 3, ^{Round Mountain Silt,} Sharktooth Hill.

Bonebed, Kern County, California.

DIAGNOSIS: As for genus.

ETYMOLOGY: Species named ⁱⁿ honor of Dr. G. Victor Morejohn.

DESCRIPTION: Both tibiotarsus and femora resemble those of the genus Cygnus.

^{← insert over} in stoutness of shaft. Positions of the ligamental and flexor attachments on the posterior face of the tibiotarsus, and relatively greater breadth than depth of distal end are suggestive of the condition in Cygnus olor (Gmelin, 1789). The anterior face of the shaft is, however, flatter and the extension of the inner cnemial crest is more flared ^{less} medially and of greater distal extent, suggesting greater diving ability. ^{mm} Measurements (in millimeters) of holotype tibiotarsus (measurements of Presbychen abavus in parentheses): Length, 151.9; breadth of distal end, 18.3 (18.6); internal depth of distal end, 16.6 (19.0); breadth of incomplete proximal end, 16.8; breadth from cnemial crest to fibular crest 14.6.

The femora resemble this element in Cygnus in the nearly straight shaft, when viewed anteriorly, which is greater in lateral breadth than antero-posterior depth. Distally the popliteal area is deeper than in Cygnus or Branta, but less sharply defined than in Merquus ^{Linnaeus,} ^{Scopolis,} The fibular condyle extends laterad slightly proximal to the external condyle, suggestive of the condition in the diving ducks, Tribe Mergini, but less abruptly protruded. In the Mergini the shaft is more curved and is relatively greater in depth than in breadth. Compared to the proximal fragment of a femur (LACM 16465) previously tentatively referred

The holotype ^{tibia/tarsus}, LACM 123991 and the paratype ^{femora}, LACM 123992 and 123993, were found associated within a few meters of one another in the quarry. At the time of collection, it appeared that these belonged to one individual, and their size, shape, preservation and stage of maturity certainly do not contradict this idea. There is, however, no way to prove the association positively, and the bones are given different catalog numbers and all kept as part of the same type series.

(Howard, 1966) to Presbychen, the head is less proximally projected.

Measurements (in mm) of ~~referred~~ ^{paratype of} femur LACM 123993 (the more complete of the two femora referred to M. morejohni): Length from neck to distal edge of rotular groove 75.4 (same as in LACM 123992); external length, 81.0; breadth of distal end, 22.6; depth of trochanter, 15.2; breadth/depth at middle of shaft, 9.5/8.5.

The characters of the referred humerus, LACM 123995, are discussed with those of humeri UCMP 93050 and LACM 122979 under Megalodytes sp.

DISCUSSION. In reporting the distal end of a femur (LACM 125994) of a large diving anatinid from the Middle Miocene of Orange County, California (Howard and Barnes, 1987) a relationship to this Sharktooth Hill anseriform material was postulated. ^{Having the specimens} ~~As now studied in more detail~~, the following ^{characters serve to} ~~distinctions of the~~ ^{distinguish it} ~~Orange County femur from the~~ femora of Megalodytes morejohni are noted: greater antero-posterior than lateral breadth of shaft, more abrupt protrusion of the fibular condyle, and popliteal area more clearly defined externally as well as internally. These characters suggest closer affinity of the Orange County femur to the Tribe Mergini than is evidenced ^{by} ~~in~~ the femora of Megalodytes morejohni.

~~cf.~~ Megalodytes sp.

Figures 1 G, H; Figure ⁵ 3 B, C, E, F

REFERRED SPECIMENS. Proximal shaft fragment and incomplete distal end with shaft of a right tibiotarsus UCMP 93051 (proximal) and UCMP 93052 (distal); and proximal 3/4 of right humerus (UCMP 93050), all from UCMP locality V71013; proximal fragment of right humerus (LACM 122979) from locality LACM 3162.

DISCUSSION. The distal end of the tibiotarsus (UCMP 93052) resembles that of the holotype of M. morejohni in the posteriorly tilted position of the supratendinal bridge; the proximal portion of the same specimen (UCMP 93051) suggests the same faintly rounded anterior surface of the shaft found in the holotype of M. morejohni. As the condylar area is incomplete both laterally and antero-posteriorly in UCMP 93052, the relative breadth to depth of the distal end

cannot be ^{measured} obtained. In breadth at the level of the supratendinal bridge, and breadth from fibular to cnemial crests, UCMP 93052 and 93051 are approximately 9 percent narrower than the holotype of M. morejohni: breadth at level of bridge UCMP 93052, 13.3 mm (in holotype M. morejohni, 14.5 mm); breadth from fibular to cnemial crests, UCMP 93051, 13.5 mm (in ^{holotype of} M. morejohni, 14.6 mm).

Humerus UCMP 93050, from the same locality as the tibiotarsal fragments, has a capital shaft ridge that is less acute and more lateral in position than in Branta. Resemblance is closer to the humerus of Cygnus in the position of the crest, although it is not as prominent as in the swan. This is true, as well, of humerus LACM 122979. In both humeri, also, the head is not undercut by the capital groove. This character, as well as the presence of the capital shaft ridge, distinguishes these specimens from the humeri of the diving ducks (Tribe Mergini). Suggestive of the condition in the extinct Chendytes is the abrupt palmar receding of the deltoid crest just distal to the external tuberosity, and its sharp reduction after a brief flare. This area is eroded in UCMP 93050, but the outline of the shaft suggests the same characters.

In the fragment of humerus (LACM 123995) referred to Megalodytes morejohni, the palmar position and reduced size of the deltoid crest (where preserved) and the seemingly lateral position of the capital shaft ridge are strongly suggestive of the condition observed in UCMP 93050 and LACM 122979. The only similar measurement possible on all three specimens is breadth of shaft just distal to the deltoid crest. This shows a size ratio close to that observed between the tibiotarsi referred to Megalodytes sp. and the holotype of M. morejohni. Breadth of shaft LACM 122979, 11.5 mm; UCMP 93050, 11.7 mm; M. morejohni LACM 123995, 12.8 mm.

The similarity of the deltoid crest in humerus UCMP 93050 and LACM 122979 to that of LACM 123995, as well as the similarities noted in the tibiotarsi, justifies assignment of this material to the genus Megalodytes. Considering the

small difference in size, the possibility of referral to M. morejohni should be considered.

cap. an. ca. 10 mm ANSERIFORMES, ^{Spp.} spp.

REFERRED SPECIMENS. Incomplete left femur, LACM 123994, from locality LACM 4956 (quarry grid section 10); proximal end of left tibiotarsus, LACM 34530, from locality LACM 1625; incomplete left tarsometatarsus, LACM 122981, from locality LACM 3161; proximal end of ulna, UCMP 95970, from locality UCMP V6323, assigned by Miller (1961) to Branta sp.

DESCRIPTION. Femur LACM 123994 is poorly preserved, lacking complete proximal and distal ends. Although similar in overall size to the femora referred to Megalodytes morejohni, it has greater antero-posterior than lateral breadth of shaft, and the popliteal area, although less deeply depressed than in M. morejohni, is more sharply defined externally by a longer ridge. Both of these femoral characters suggest possibly even greater adaptation for diving than is seen in the femora of M. morejohni.

The proximal fragment of tibiotarsus (LACM 34530) has the medially flared distal continuation of the internal cnemial crest characteristic of the divers, possibly to an even greater distal extent relative to the size of the bone than in the holotype of Megalodytes morejohni. However, it resembles that specimen in the position of the rugosities marking the muscle attachments on the posterior side. Measurements show the specimen to be even smaller than tibiotarsus UCMP 93051 listed herein as Megalodytes sp.: breadth from fibular to cnemial crests, 12.5 mm in LACM 34530, 13.5 mm in UCMP 93051.

Tarsometatarsus LACM 122981 has a long internal calcaneal ridge, even longer than in Cygnus, and notably longer than in members of the Tribe Mergini. The specimen is markedly distinguished from the tarsometatarsus of Cygnus by the abrupt narrowing of the internal side of the shaft anteriorly, immediately below

the proximal end, and the gradual diminution in breadth (while retaining its depth) towards the distal end. This abrupt narrowing of the shaft is particularly noteworthy in distinction to the proximal end of tarsometatarsus (LACM 16466) previously identified (Howard, 1966) as Presbychen abavus. ^A Much narrower metatarsal shaft is characteristic of diving forms such as the grebes and loons.

The proximal end of ulna that Miller (1961) assigned to Branta sp., noting that it was too small to be assigned to Presbychen, is similar in size to large specimens of B. canadensis (Linnaeus, 1758), but with both olecranon and shaft markedly straighter. The high, straight olecranon is suggestive of the condition in Melanitta, Boie, 1822, but the straight shaft more closely resembles that of Cygnus, Bechstein, 1803.

Were it not for the occurrence of femur LACM 123994, which clearly represents a diver distinct from M. morejohni, these specimens might well have been assigned to Megalodytes.

DISCUSSION. Only one other anseriform species has been described from the Miocene of California, Branta howardae L. Miller, 1930 (see Howard, 1983). The species is based on a single distal fragment of carpometacarpus from the Late Miocene Dove Springs Formation (originally named Ricardo Formation and considered to be of Lower Pliocene age) in the Mohave desert, Kern County, ^{California} ^{are} There is no possibility of comparison of this fragment with the Sharktooth Hill material ^{with} ^{carpometacarpus in the} ^{which to compare this specimen and} Miller (1961) made no reference to it in discussing the ulna he assigned to Branta sp. from the latter locality.

Three other anseriform species have been described from earlier Miocene beds of North America: Paranyroca magna A. Miller and Compton, 1939; Dendrochen robusta A. Miller, 1944; and Anas integra A. Miller, 1944. All are from the Lower Miocene of Bennett County, South Dakota. Paranyroca is known only from two tarsometatarsi, for which the authors established a new "distinctive and

primitive anseriform family," the Paranyrociidae, which they said "may have some special phylogenetic relation with the Nyrociinae," ^(O.P. et al. p. 154) The holotype of Dendrochen robusta is a humerus ^{that} ~~which~~ Miller placed in the Tribe Dendrocygnini. The medial placement of the capital shaft ridge and the strong undercutting of the head by the capital groove distinguish the specimen from the humeri assigned to Megalodytes. Anas integra (placed in the subfamily Anatinae) is known from a coracoid (holotype) and ulna. Both ^{specimens} clearly represent a small anatine duck, obviously not related to Megalodytes.

CONCLUSIONS

In studying the material discussed herein it became clear that at least two extinct Middle Miocene species of large anseriform birds are present in the Sharktooth Hill Local Fauna, namely Presbychen abavus Wetmore, 1930 and Megalodytes morejohni new genus and species. It is impossible to determine from the material available whether the smaller specimens herein identified only as Megalodytes sp. represent a separate species.

While Presbychen appears to have been a goose-like bird, Megalodytes ^{was} ~~is~~ more like the swans, though with additional adaptations for diving. The temptation was strong to list this new genus under the Mergini. I felt, however, that the adaptations to diving ^{for} ~~observed~~ were secondary. Or, perhaps, we may postulate that ancient swans had greater diving ability, which has gradually diminished through time.

Of the fourteen anseriform specimens now known from Sharktooth Hill, four do not readily fall within either of the above genera, and should best be classified only as Anseriformes spp.

In summary the anseriform specimens from Sharktooth Hill are evaluated as follows (number of specimens in parentheses):

Order Anseriformes

Family Anatidae

Subfamily Anserinae

Tribe Cygnini

Genus Megalodytes (7)

Tribe Anserini

Genus Presbychen (3)

Anseriformes spp. (4)

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I am especially grateful to ~~Dr.~~ Pierce Brodkorb of the University of Florida who, when I met with difficulty in finding a scientific name ~~not~~ already in use for a diving bird of large size, came up with the suggestion of Megalodytes.

The bones were prepared for photographing by Howell Thomas of the LACM Vertebrate Paleontology Laboratory, photographed by John DeLeon, LACM Photographer, and arranged for plates by Mary Butler of the LACM Exhibitions Division.

LITERATURE CITED

- Addicott, W.O. 1972. Provincial middle and late Tertiary molluscan stages, Temblor Range, California. ^{Pp 1-26} In Proceedings of the Pacific Coast Miocene Biostratigraphic Symposium, Society of Economic Paleontologists and Mineralogists, (ed. E. H. Stinemeyer), 1-26.
- Barnes, L.G. 1976. Outline of eastern North Pacific fossil cetacean assemblages. Systematic Zoology 25(4):321-343.
- Barnes, L.G., and E. D. Mitchell. 1984. Kentriodon obscurus (Kellogg, 1931), A fossil dolphin (Mammalia: Kentriodontidae) from the Miocene Sharktooth Hill Bonebed in California. Contributions in Science, Natural History Museum of Los Angeles County 353:1-23.
- Howard, H. 1966. Additional avian remains from the Miocene of Sharktooth Hill, California. Los Angeles County Museum Contributions in Science 114:1-11.
- 1983. A list of the extinct fossil birds of California. Bulletin of the Southern California Academy of Sciences, 82(1):1-11.
- 1984. Additional avian records from the Miocene of Kern County, California with the description of a new species of fulmar (Aves: Procellariidae). Bulletin of the Southern California Academy of Sciences, 83(2):84-89.
- Howard, H. and L.G. Barnes. 1987. Middle Miocene marine birds from the foothills of the Santa Ana Mountains, Orange County, California. Contributions in Science Natural History Museum of Los Angeles County 383:1-9.
- Miller, A.H. 1944. An avifauna from the Lower Miocene of South Dakota. University of California Publications Bulletin Department of Geological Sciences: 27:85-99.
- Miller, A.H. and L.V. Compton. 1939. Two fossil birds from the Lower Miocene of South Dakota. Condor 40: 153-156.

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 NOT AVAILABLE

Miller, L. 1925. Chendytes, a diving goose from the California Pleistocene.

Condor, 27:145-147.

----- . 1961. Birds from the Miocene of Sharktooth Hill, California. Condor
 63:399-402.

1965. History of Research at Sharktooth Hill, Kern County, California
 Mitchell, E.D. 1966. The Miocene pinniped Allodesmus. University of California
 Publications in Geological Sciences 61:1-46, pls. 1-29.

Wetmore, A. 1930. Fossil bird remains from the Temblor Formation near
 Bakersfield, California. Proceedings of the California Academy of
 Sciences, 4th ser., 19:85-93.

Wood, H. E., 2nd, R.W. Chaney, J. Clark, E.H. Colbert, G.L. Jepson, J.B. Reeside,
 Jr., and C. Stock. 1941. Nomenclature and correlation of the North
 American continental Tertiary. Geological Society of America Bulletin
 52:1-48, pl. 1.

Miller, L. 1925. History of Research at Sharktooth Hill,
 Kern County, California, 40:1-14, fig. 1.

45/19/14/18/81

FIGURES

Figure 1. Anserine tibiotarsi: A-C Presbychen abavus, holotype USNM 11973; A, posterior, B, internal, C, anterior views; Megalodytes morejohni LACM 123991; holotype: D, anterior, E, posterior, F, internal views; Megalodytes sp., anterior view; G, distal end UCMP 93052; H, proximal fragment UCMP 93051.

Figure 2. Femora referred to Megalodytes morejohni: right, LACM 123993; A, posterior; B, external; C, anterior views; left, LACM 123992; D, posterior, E, external, F, anterior views.

Figure 3. Megalodytes humeri: A-C anconal, and D-F palmar views. A, D Megalodytes morejohni LACM 123995; B, E Megalodytes sp., LACM 122979; C, F Megalodytes sp., UCMP 93050. (37 mm of incomplete shaft of 93050 not shown.)



A



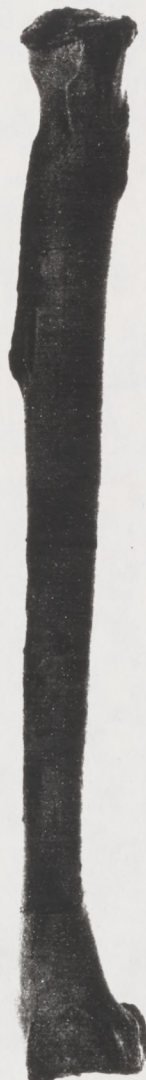
B



C



D



E



F



H



G

A, B, C *Prachina*
12010/10/10
11973

LACM D E F
123991
Megachasma
megachasma
holotype

Megachasma
4 pairs, UCNP 93050
G det UCNP 93052

Fig 1



A



B



C

right femur 123993



D



E



F

left femur 123992



A



B



C



D



E



F

A" and D
LACM 123995
m. m. *oregani* referred

Megaladytes sp.
3 C, D' prox. femur
at Linn. VCM 13050
3 B, E prox. at Linn. LACM 123999



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